Ecology of Mathematics

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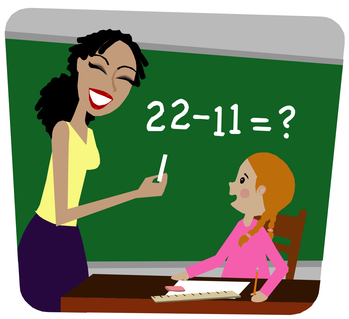
Introduction

•Genetics show that there are shared genetic and environmental influences on math.
•Few studies have examined the ecological effects influencing mathematics and relatively little is known about the environmental etiologies of math abilities and disabilities (Kovas, Haworth, Petrill, & Plomin 2007).
•This study aims at finding the relationship of children's school life, family life, and exclusive environment on mathematical achievement.
•No study has looked at specific environmental variables affecting math attainment.

Objectives:

•What environmental factors are associated with mathematical ability?
- •Family environment
- •School environment
- •Child environment (during testing)

•How strongly correlated are these factors to mathematical success?



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Methods

Participants:

Sample derived from the Western Reserve Reading and Math Project (WRRMP), a sample of 384 children in 3 major cities in Ohio, U.S.
- •*M* child age = 12 years
- •*M* highest parent education = 4 year college degree

Measures of the Environment:

1. **Teacher Measure of School Environment:** Teacher Report Form (TRF): assesses the classroom and school environment
2. **Tester Measure of Child's Environment:** Bayley Behavior Rating (BBR): examines the child's behavior and willingness to complete mathematical tasks
3. **Tester Measure of Home Environment:** Post-Visit Rating (PVR): an intense analysis of home environment by the home-visit tester
4. **Child Measure of School, Home, and Child's Environment:** Child Questionnaire (CQ): child's own assessment of his environment with three parts:
   i. Child self reported math grades
   ii. CHAOS: measures the perception of confusion and disorganization in home
   iii. School/Teacher relationship
5. **Parent Measure of Home Environment:** Socioeconomic Status (SES): parent's highest reported education level

Measures of Math Performance:

1. **WJ III Calculation:** timed and non-timed computation tests —the most statistically significant predictor of mathematical intelligence (Hart, Petrill, Thompson, Plomin 2009)
   •reliability = .85
2. **WJ III Fluency:** a three minute computation test of accuracy and speed
   •reliability = .89
3. **WJ III Applied Problems:** problems that assess the child's ability to decide which mathematical operation to use and apply it to the calculation
   •reliability = .92

Results

Descriptive Statistics

•This sample's average math abilities (as judged by the three Woodcock Johnson math measures) are slightly higher when compared to the general population.

• The table of standardized scores indicates a range of scores at or near 2 standard deviations above and below the mean for all three math variables.

	Min	Max	Mean	Std. Dev.
Calculation	60	146	101.53	14.557
Math Fluency	68	191	100.67	15.484
Applied Problems	60	134	107.04	11.557

Regression

•In order to further explore the pattern of correlations, Exploratory Factor Analysis was necessary.

•Regression analyses were conducted in order to see simultaneous predictions of the independent variables and whether they have an independent contribution to the outcome.

•Three CQ variables and three TRF variables were also condensed into sets.

Calculation

	R Square	F	Sig.	R Square Change	F Change	Sig. F Change
CHAOS	.056	5.918	.017	.056	5.918	.017
CQ School	.102	2.747	.033	.046	1.651	.183
TRF	.177	2.891	.009	.075	2.871	.041
PVR	.192	2.754	.009	.014	1.654	.202
SES	.192	2.424	.016	.000	.023	.879

Fluency

	R Square	F	Sig.	R Square Change	F Change	Sig. F Change
CHAOS	.082	9.317	.003	.082	9.317	.003
CQ School	.103	2.915	.025	.021	.799	.497
TRF	.159	2.651	.015	.056	2.164	.097
PVR	.183	2.721	.009	.024	2.862	.094
SES	.200	2.671	.008	.017	2.039	.157

Applied Problems

	R Square	F	Sig.	R Square Change	F Change	Sig. F Change
CHAOS	.038	4.108	.045	.038	4.108	.045
CQ School	.085	2.333	.061	.047	1.713	.169
TRF	.113	1.775	.101	.028	1.029	.383
PVR	.119	1.645	.122	.007	.763	.385
SES	.138	1.701	.099	.018	2.013	.159

Discussion

•Results indicate that organization in the home is a statistically significant predictor of math abilities (r = -.174, p = .05 with Calculation)

•Child's self-reported math grade in school is also statistically significantly correlated with the child's actual mathematical abilities.

•Socioeconomic status is a good predictor of math abilities; children from higher SES demonstrate higher levels of math ability (r = .239, p = .05 with Applied Problems).

•Results also demonstrate that the child's ability to self-regulate and control emotions is positively correlated with mathematical ability.

•These results show that certain aspects of school promote specific mathematical abilities. Based on the results, the environmental level factors are individually associated with math.

•These results are similar to the Hart, Petrill et al. (2007) study that gave evidence that CHAOS is an important environmental mediator of general cognitive ability.

•These results suggest that environment plays an important role on a child's math ability.